Amendments to the Claims

Please amend claims 102-107. This listing of claims replaces all prior versions, and listings, of claims in the application:

Listing of Claims

1. (Previously Presented) A method for forming an array of a sample material on a surface of a substrate and analyzing the sample material in the resulting array, comprising:

providing a vesicle that has an interior chamber containing a fluid comprising a solvent containing the sample material;

disposing said vesicle adjacent to a first location on said surface of the substrate without contacting the surface with the vesicle;

providing mechanical pressure to the interior of the vesicle to eject from said chamber a defined and controlled 0.2 to 20 nanoliter volume of the fluid to dispense said fluid at said first location of said surface of the substrate;

moving said vesicle to each of a set of positions adjacent to the surface of the substrate, whereby a defined and controlled 0.2 to 20 nanoliter volume of fluid is dispensed at each location of said set forming an array of spots of sample material on the substrate such that spot-to-spot characteristics are reproducible in the array; and

performing mass spectrometry analysis of the sample material at each location of the array, wherein mass spectra of the sample obtained from each spot are reproducible within the array of spots.

2. (Previously Presented) A method of claim 1, wherein the substrate has wells formed thereon for defining locations for receiving said fluid ejected from said chamber.

3. (Previously Presented) A method of claim 1, wherein the sample material comprises a matrix material for mass spectrometry.

4. (Previously Presented) A method of claim 3, including the further step of waiting a predetermined period of time to allow the solvent containing the matrix material to evaporate on the surface of the substrate thereby depositing the matrix material on the surface.

5. (Previously Presented) A method for forming an array of a sample material on a surface of a substrate and analyzing the sample material in the resulting array, comprising:

providing a vesicle that has an interior chamber containing a fluid comprising a solvent containing material for deposition;

disposing said vesicle adjacent to a first location on said surface of the substrate without contacting the surface with the vesicle;

providing mechanical pressure to the interior of the vesicle to eject from said chamber a defined and controlled 0.2 to 20 nanoliter volume of the fluid to dispense solvent containing matrix material at said first location of said surface of the substrate, wherein the matrix material is for matrix-assisted laser desorption mass spectrometry;

moving the vesicle to each of a set of positions adjacent to the surface of the substrate, whereby a defined and controlled 0.2 to 20 nanoliter volume of solvent containing a matrix material is dispensed at each locus of the array;

waiting a predetermined period of time to allow the solvent containing the matrix material to evaporate on the surface of the substrate thereby depositing the matrix material on the surface;

moving said vesicle to each of a set of positions adjacent to the surface of the substrate, whereby a defined and controlled 0.2 to 20 nanoliter volume of fluid containing an analyte material is dispensed onto said evaporated matrix material at each locus of the array to dissolve with said matrix material and to form a crystalline structure at each locus of the substrate surface such that spot-to-spot characteristics are reproducible in the array; and

performing mass spectrometry analysis of the sample material at each location of the array, wherein mass spectra of the material obtained from each spot are reproducible within the array of spots.

6. (Previously Presented) A method of claim 1, wherein the sample material comprises solvent containing an analyte material and a matrix material for mass spectrometry.

7. (Cancelled).

8. (Cancelled).

9. (Previously Presented) A method of claim 1, wherein the vesicle further comprises a piezoelectric element that provides the pressure for ejecting the nanoliter volume of fluid from the chamber.

10. (Previously Presented) A method of claim 1, wherein said step of moving said vesicle includes the step of rastering said vesicle across said surface of said substrate.

11. (Previously Presented) A method of claim 1, wherein the vesicle is part of a vesicle assembly having a plurality of vesicles arranged into a matrix for dispensing fluid to a first plurality of locations onto said substrate surface.

12. (Previously Presented) A method of claim 11, wherein said step of moving said vesicle includes the step of determining an offset signal representative of a distance for moving the vesicle assembly containing the vesicle to a location next to the first plurality of locations.

13. (Previously Presented) A method of claim 12 wherein said step of moving the vesicle includes the step of moving said vesicle assembly over said surface of said substrate and dispensing fluid therefrom to form a matrix of locations having fluid ejected thereon.

14. (Previously Presented) A method of claim 1, including the further step of drawing a wash fluid into said chamber of said vesicle to rinse said chamber.

15. (Previously Presented) A method of claim 1, including the further step of contacting said vesicle to a source of fluid material for filling said chamber by capillary action.

16. (Previously Presented) A method of claim 1, including the step of providing the substrate material comprising silicon.

17. (Previously Presented) A method of claim 1, including the step of providing the substrate material comprising a metal material.

18. (Previously Presented) A method of claim 1, including the step of providing the substrate material comprising a plastic material.

19. (Previously Presented) A method of claim 1, including the step of providing the substrate, comprising a membrane.

20. (Previously Presented) A method of claim 1, including the step of providing the substrate, comprising a polymeric material.

21. (Previously Presented) A method of claim 1, including the step of providing the substrate, comprising metal-grafted polymers.

22. (Previously Presented) A method of claim 1, including the step of providing the substrate, wherein the substrate is a chemically functionalized substrate material.

23. (Previously Presented) A method of claim 1, including the step of providing the substrate, wherein the substrate is functionalized with beads.

24. (Previously Presented) A method of claim 1, including the step of providing the substrate, wherein the substrate is functionalized with a dendritic material.

25. (Previously Presented) A method for analyzing a material, comprising:

providing a vesicle comprising a fluid containing the material in a solvent;

disposing said vesicle adjacent to a first location of a surface of a substrate without contacting the surface with the vesicle;

delivering a defined and controlled nanoliter volume of the fluid at the first location of said surface of the substrate;

moving said vesicle to a second position next to the first location on said surface of the substrate to dispense a defined and controlled nanoliter volume of said material along an array of locations on said substrate surface to form an array of the material such that spot-to-spot characteristics are reproducible in the array; and

performing mass spectrometry analysis for said material at each location of said array, wherein mass spectra of the material obtained from each spot are reproducible within the array of spots.

26. (Previously Presented) A method of claim 25, wherein said step of providing a vesicle, includes the step of mixing a matrix material and an analyte material to form said fluid containing the material.

27. (Previously Presented) A method of claim 25, including the steps of providing a vesicle having an interior chamber suitable for holding the fluid wherein the material comprises a matrix material for mass spectrometry.

28. (Previously Presented) A method of claim 25, wherein said step of performing mass spectrometry includes the step of performing matrix assisted laser desorption ionization mass spectrometry.

29. (Previously Presented) A method of claim 25, wherein said step of performing mass spectrometry includes the step of performing a time of flight mass spectrometry analysis.

30. (Previously Presented) A method of claim 25, wherein said step of performing mass spectrometry includes the step of performing a fourier transform mass spectrometry analysis.

31. (Previously Presented) A system for forming an array of a sample material on a surface of a substrate and analyzing the sample material in the array, comprising:

a vesicle having a distal end suitable for carrying a nanoliter of fluid;

a movable arm having a distal portion mounted to move said vesicle;

a controller for moving said arm to dispose said vesicle adjacent to a first location on said surface of the substrate and for controlling said vesicle to deliver a defined and controlled 0.2 to 20 nanoliter volume of the fluid at said first location of said surface of the substrate; and

a mass spectrometer for analyzing said material deposited on said surface of said substrate, wherein mass spectra of the sample material obtained from each spot are reproducible within the array of spots.

32. (Previously Presented) A system of claim 31, wherein said vesicle comprises a solid shaft of material.

33. (Previously Presented) A system of claim 31, wherein said vesicle comprises an interior chamber suitable for carrying a fluid material.

34. (Previously Presented) A system of claim 31, wherein said vesicle comprises a chamber and a transducer element for ejecting fluid from said chamber.

35. - 39. (Cancelled).

40. (Previously Presented) A method for dispensing sub to low nanoliter volumes of a material as an array onto the surface of a substrate, comprising the steps of:

(a) providing an assembly having a plurality of vesicles arranged in the form of an array for dispensing a liquid therefrom, wherein each vesicle has an interior chamber containing a fluid containing the material;

(b) aligning the vesicles at a first set of locations adjacent to the surface of the substrate without contacting the surface with the vesicles;

(c) using mechanical pressure, controlling each of the chambers to eject a defined and controlled 0.2 to 20 nanoliter volume of the fluid from each vesicle onto the surface of the substrate aligned with the vesicles, whereby an array of spots of the fluid is deposited on the surface of the substrate, such that spot-to-spot characteristics are reproducible in the array; and

(d) providing the resulting substrate with the array of material deposited thereon to a mass spectrometer and determining information representative of the composition of the deposited material, wherein mass spectra of the material obtained from each spot are reproducible within the array of spots.

41. (Previously Presented) A method of claim 40, further comprising the steps of:

(e) moving the assembly of step (a) to align the vesicles at a second set of locations adjacent to the surface of the substrate;

(f) repeating step (c); and

(g) optionally repeating steps (e) and (f) to dispense fluid at additional sets of locations on the surface of the substrate.

42. (Original) A method of claim 40, wherein the substrate has wells formed on the surface of the substrate for defining locations for receiving the fluid ejected from the vesicles.

43. (Original) A method of claim 40, wherein the fluid comprises a solvent and a matrix material.

44. (Original) A method of claim 43, including the further step of waiting a predetermined period of time to allow the solvent comprising the matrix material to evaporate from the fluid ejected onto the surface of the substrate leaving the matrix material deposited on the surface.

45. (Previously Presented) A method of claim 44, further comprising repeating steps of (a) through (c) at the same locations on which the matrix material is deposited, wherein the chambers of the vesicles in the assembly contain a solvent comprising an analyte material, which upon ejection on the array of matrix material dissolves into the matrix.

46. (Previously Presented) A method of claim 41, wherein:

the fluid comprises matrix material in a solvent;

steps of (a) through (g) are repeated at the same locations on which the matrix material is deposited, wherein the chambers of the vesicles in the assembly contain a solvent comprising an analyte material, which upon ejection on the array of matrix material dissolves into the matrix.

47. (Original) A method of claim 40, wherein the fluid comprises an analyte in a solvent.

48. (Original) A method of claim 47, including the further step of waiting a predetermined period of time to allow the solvent comprising analyte to evaporate from the fluid ejected onto the surface of the substrate leaving the analyte material deposited on the surface.

49. (Previously Presented) A method of claim 48, further comprising repeating steps of (a) through (c) at the same locations at which analyte is deposited, wherein the chambers of the vesicles in the assembly contain a solvent comprising a matrix material, which upon ejection onto the array of analyte dissolves into the analyte.

50. (Previously Presented) A method of claim 41, wherein:

the fluid comprises an analyte in a solvent;

the method includes the further step of waiting a predetermined period of time to allow the solvent comprising analyte to evaporate from the fluid ejected onto the surface of the substrate leaving the analyte material deposited on the surface; and

steps of (a) through (g) are repeated at the same locations at which analyte is deposited, wherein the chambers of the vesicles in the assembly contain a solvent comprising a matrix material, which upon ejection onto the array of analyte dissolves into the analyte.

51. (Previously Presented) A method of claim 40, wherein the fluid comprises a mixture of analyte material and matrix material.

52. - 53. (Cancelled).

54. (Previously Presented) A method of claim 41, wherein the step of moving the assembly includes the step of rastering the assembly across the surface of the substrate.

55. (Previously Presented) A method of claim 41, wherein the step of moving the assembly includes the step of determining an offset signal representative of a distance for moving the assembly to align the vesicles at a location adjacent to the first set of locations.

56. (Previously Presented) A method of claim 40, including the further step of drawing a wash fluid into the chambers to rinse the chambers.

57. (Previously Presented) A method of claim 40, wherein:

each vesicle comprises a pin having a chamber of sufficiently narrow bore to allow the chamber to at least partially fill with fluid by capillary action; and

the vesicles of the assembly are contacted with a source of fluid to at least partially fill the chambers with a volume of fluid by capillary action.

58. (Previously Presented) A method of claim 57, wherein:

the chambers of the vesicles are connected to a pressure source; and a positive pressure from the pressure source is applied to the chamber to partially offset a volume of fluid that fills the chamber by capillary action.

59. (Previously Presented) A method of claim 40, wherein:

the chambers of the vesicles are connected to a pressure source that applies a negative pressure to the chamber; and

fluid is introduced into the vesicles by contact with a fluid source to at least partially fill the chambers with a volume of fluid by negative pressure.

60. (Previously Presented) A method of claim 40, wherein the substrate comprises material selected from the group consisting of silica, glass, cellulose, silicon, metal, plastic, polymer and metal-grafted polymer.

61. (Previously Presented) A method of claim 40, wherein the substrate comprises a flat surface, a flat surface with pits, a solid or porous bead, a membrane or a pin.

62. (Cancelled).

63. (Previously Presented) A method of claim 40, wherein the fluid comprises an oligonucleotide.

64. (Previously Presented) A method of claim 40, wherein:

the chambers of the vesicles are connected to a pressure source; and

controlling the vesicles to eject fluid is effected by applying positive pressure to the chambers of the vesicles by the pressure source.

65. (Previously Presented) A method of claim 64, wherein the pressure in the chamber of the vesicle is sufficient to result in ejection of a spray of the fluid from the vesicle.

66. (Previously Presented) A method of claim 64, wherein the pressure in the chamber of the vesicle is selected to result in ejection of droplets of the fluid from the vesicle.

67. (Previously Presented) A method of claim 40, wherein each vesicle of the assembly comprises an assembly having a capillary element for directing the fluid to the surface of the substrate and a transducer element for applying pressure to the jet to dispense the fluid.

68. (Previously Presented) A method of claim 67, wherein the transducer element is disposed around the capillary and can transform an electrical pulse into mechanical deformation of the capillary, resulting in ejection of fluid from the capillary.

69. (Previously Presented) A method of claim 67, wherein the transducer element is selected from the group consisting of piezoelectric, electric, electrorestrictive, magnetorestrictive and electromechanical transducers.

70. (Previously Presented) A method for dispensing nanoliter volumes of a material as an array on the surface of a substrate and analyzing the material in the array, comprising the steps of:

(a) providing a pin assembly having a plurality of elongated vesicles arranged as an array for dispensing a liquid therefrom, wherein each vesicle comprises a solid shaft of material having an end for retaining a nanoliter volume of fluid;

(b) loading a nanoliter volume of fluid comprising a liquid material from a fluid source onto the end of the vesicles of the pin assembly;

(c) disposing the pin assembly to align the vesicles at a first set of locations adjacent to a surface of the substrate without contacting the surface with the vesicles;

(d) contacting the loaded fluid to the surface of the substrate aligned with the vesicles to deposit a defined and controlled 0.2 to 20 nanoliter volume at each location, whereby an

array of spots of material on the surface of the substrate is formed, such that spot-to-spot characteristics are reproducible in the array; and

(e) analyzing the array of material on the surface of the substrate by mass spectrometry, wherein:

mass spectra of the material obtained from each spot are reproducible within the array of spots;

the substrate comprises matrix material;

the fluid comprises analyte material;

the fluid of analyte material at the end of the vesicles is contacted with the evaporated matrix material on the surface of the substrate to dissolve the matrix material with the analyte material and thereby deposit a mixture of matrix and analyte material.

71. (Previously Presented) A method of claim 70, further comprising the steps of:

(f) repeating step (b);

(g) moving the pin assembly to align the vesicles at a second set of locations adjacent to the surface of the substrate and adjacent to the first set of locations;

(h) repeating step (d); and

(i) optionally repeating steps (f) through (h) to dispense material at additional locations on the substrate.

72. (Previously Presented) A method of claim 70, wherein the substrate has wells formed on the surface of the substrate for defining locations for receiving the fluid ejected from each vesicle.

73. - 77. (Cancelled).

78. (Previously Presented) A method for dispensing nanoliter volumes of a material as an array on the surface of a substrate and analyzing the material in the array, comprising the steps of:

(a) providing a pin assembly having a plurality of elongated vesicles arranged as an array for dispensing a liquid therefrom, wherein each vesicle comprises a solid shaft of material having an end for retaining a nanoliter volume of fluid;

(b) loading a nanoliter volume of fluid comprising a liquid material from a fluid source onto the end of the vesicles of the pin assembly;

(c) disposing the pin assembly to align the vesicles at a first set of locations adjacent to a surface of the substrate without contacting the surface with the vesicles;

(d) contacting the loaded fluid to the surface of the substrate aligned with the vesicles to deposit a defined and controlled 0.2 to 20 nanoliter volume at each location, whereby an array of spots of material on the surface of the substrate is formed, such that spot-to-spot characteristics are reproducible in the array; and

(e) analyzing the array of material on the surface of the substrate by mass spectrometry, wherein:

mass spectra of the material obtained from each spot are reproducible within the array of spots;

steps of (a) through (d) are first performed with the vesicles containing a fluid comprising analyte material; and

after a predetermined time during which the analyte material evaporates on the surface, steps (a) through (d) are repeated to deposit fluid containing matrix material such that the fluid of matrix material at the end of the vesicles is contacted with the evaporated analyte material on the surface of the substrate to dissolve the matrix material with the analyte material and thereby deposit a mixture of matrix and analyte material.

79. - 81. (Cancelled).

82. (Previously Presented) A method of claim 71, wherein the step of moving the pin assembly includes the step of rastering the pin assembly across the surface of the substrate.

83. (Previously Presented) A method of claim 71, wherein the step of moving the pin assembly includes the step of determining an offset signal representative of a distance for moving the pin assembly to align the vesicles at a location adjacent the first set of locations.

84. (Previously Presented) A method of claim 70, wherein the substrate comprises material selected from the group consisting of silica, glass, cellulose, silicon, metal, plastic, polymer, and metal-grafted polymer.

85. (Previously Presented) A method of claim 70, wherein the substrate comprises a flat surface, a flat surface with pits, a solid or porous bead, a membrane or a pin.

86. (Previously Presented) A method of claim 70, wherein the surface of the substrate is functionalized chemically, functionalized with beads or functionalized with dendrites of captured material.

87. (Previously Presented) The method of claim 1, wherein the vesicle is part of an assembly of vesicle elements, wherein each vesicle comprises an interior chamber holding the 0.2 to 20 nanoliter volumes of fluid.

88. (Previously Presented) The method of claim 87, wherein:

the vesicles are inside a housing that has an interior chamber connected to a pressure source that controls the pressure within the interior housing; and

the pressure source provides pressure to chamber of the housing to regulate the flow of fluid through the interior chamber of each vesicle, thereby dispensing the controlled and defined nanoliter volumes of fluid from the vesicles.

89. (Previously Presented) The method of claim 1, wherein:

the vesicle has an interior chamber and forms part of an assembly comprising a plurality of vesicles and a transducer element mounted to each vesicle for driving fluid through the interior chamber to eject fluid by deforming the chamber; and

the transducer element deforms the chamber with sufficient pressure to spray the fluid from the pin or to cause a drop of fluid to extend from the chamber so that fluid can be passed to the substrate by contacting the drop to the surface of the substrate.

90. (Previously Presented) The method of claim 1, that is automated.

91. (Previously Presented) The method of claim 1, wherein the mass spectrometry format is matrix assisted laser desorption ionization mass spectrometry.

92. (Previously Presented) The system of claim 31, wherein the mass spectrometry format is matrix assisted laser desorption ionization mass spectrometry.

93. (Previously Presented) The method of claim 40, wherein the mass spectrometry format is matrix assisted laser desorption ionization mass spectrometry.

94. (Previously Presented) The method of claim 70, wherein the mass spectrometry format is matrix assisted laser desorption ionization mass spectrometry.

95. - 101. (Cancelled).

102. (Currently Amended) The method of claim 1, wherein the substrate comprises any one of or combinations of silicon, metal, plastic, a membrane, polymeric material, a metal-grafted polymer; and the substrate is optionally functionalized chemically, [a] functionalized with beads, functionalized with dendrite trees of captured material and combinations thereof.

103. (Currently Amended) The method of claim 25, wherein the substrate comprises any one of or combinations of silicon, metal, plastic, a membrane, polymeric material, a metal-grafted polymer; and the substrate is optionally functionalized chemically, [a] functionalized with beads, functionalized with dendrite trees of captured material and combinations thereof.

104. (Currently Amended) The system of claim 31, wherein the substrate comprises any one of or combinations of silicon, metal, plastic, a membrane, polymeric material, a metal-grafted polymer; and the substrate is optionally functionalized chemically, [a] functionalized with beads, functionalized with dendrite trees of captured material and combinations thereof.

105. (Currently Amended) The method of claim 40, wherein the substrate comprises any one of or combinations of silicon, metal, plastic, a membrane, polymeric material, a metal-grafted polymer; and the substrate is optionally functionalized chemically, [a] functionalized with beads, functionalized with dendrite trees of captured material and combinations thereof.

106. (Currently Amended) The method of claim 70, wherein the substrate comprises any one of or combinations of silicon, metal, plastic, a membrane, polymeric material, a metal-grafted polymer; and the substrate is optionally functionalized chemically, [a] functionalized with beads, functionalized with dendrite trees of captured material and combinations thereof.

107. (Currently Amended) The method of claim 78, wherein the substrate comprises any one of or combinations of silicon, metal, plastic, a membrane, polymeric material, a metal-grafted polymer; and the substrate is optionally functionalized chemically, [a] functionalized with beads, functionalized with dendrite trees of captured material and combinations thereof.